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SUMMARY OF ISSUES AND PROBLEMS IN INFERRING A LEVEL OF ACCEPTABLE RISK

Steven L. Salem
Kenneth A. Solomon

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PREFACE

DOE Contract

This Paper summarizes some of the policy findings of R-2561-DOE, "Issues and Problems in Inferring a Level of Acceptable Risk," S. L. Salem, K. A. Solomon, M. Yesley, July 1980, and generalizes these findings to address a broader audience than the Department of Energy (DOE), ~~our original client.~~ This Paper is addressed to people concerned with managing risk and safety at all levels of government - Federal, State, and Municipal, as well as risk managers in private industry.

SUMMARY OF ISSUES AND PROBLEMS IN INFERRING A LEVEL OF ACCEPTABLE RISK

As modern society becomes increasingly dependent on the benefits of technological expertise, it concomitantly faces the problem of avoiding the potential harms and risks, both chronic and catastrophic, that inevitably accompany technological innovation. In the United States, it has befallen governmental regulatory agencies--and specifically that vague person "the risk manager"--to both develop and apply a plan whose purpose is to steer society between an uncompromising stand against progress and a headlong plunge into the technological whirlpool and the inevitable technological risks. The plan by which regulatory agencies must operate is some form of tradeoff between potential benefits and potential risks.

In a recent study, we address only a part of that tradeoff; specifically, we examine two fundamental ingredients of that tradeoff--the concepts of (1) risk acceptance criteria and (2) risk management by goal. We consider such risk-reduction goals as the minimization of accident probabilities, minimizations of maximum accident consequences, "as low as reasonably achievable" risk goals, minimization of socially perceived risks, etc. and how their implicit use affects energy policy decisions. And, in examining these ingredients, we provide some observations on how to improve the framework for managing risk.

The utility of this study emanates from at least three fundamental findings:

- Society cannot quantify a risk acceptance criterion acceptable to all people for all forms of risk.
- Different regulatory bodies and different members of the same regulatory body seek to attain different risk-reduction goals, even for identical risks.
- The acceptability of selected energy technologies can vary significantly as a function of which of these risk-reduction goals are used.

Thus, the implicit choice of the risk-reduction goals utilized becomes a key risk regulation. Furthermore, any agency which regulates risks, either directly or indirectly, should explicitly recognize, and consider the impact of, the goals it may implicitly be using. In short, we contend that *Risk Managers in Federal, State, and Municipal Government as well as private industry need to be more self-aware in specifying what its risk-reduction goals are, as well as how they relate both to those of other agencies and interested parties, and to the energy alternatives in question.*

Our fundamental position is that risk managers can do a better job of steering society if they are self-aware. We recommend that rather than making individual decisions on the basis of sets of isolated criteria in vogue at the time, risk managers must have instead an overall sense of what goals they want to achieve, how their regulatory strategies are constructed in the service of these goals, and how their own special mission fits into the larger context of both the collectivity of all regulatory bodies and the American society itself.

As an example, during the initial stages of deciding which energy options to pursue, DOE should consider not only questions of technological risk versus benefit, economic and technical feasibility, etc., but should fundamentally consider:

- The long run risk-reduction goals of DOE in contrast to its more rapidly varying, short-term goals; also the goals of other government agencies, regulatory bodies, and various public segments.
- The potential for the technology in question to achieve DOE's goals and possibly the other goals, as well as the potential for competing technologies to achieve these same goals.

We now examine the findings and policy recommendation reported in R-2561-DOE in turn.

Our Findings

To arrive at our first finding, that society cannot quantify a single risk acceptance criterion, we do two things in the report. First, we examine differences in incurred risks and differences in levels of risk accepted by regulatory bodies, in order to ascertain the dimensions along which such differences lie. To this end, we examine mortality and accident statistics for a number of activities and technologies, and also consider how various regulations compare to medically and statistically ascertained risk levels for these activities and technologies. In the process of making this examination, we note some ambiguities of measurement that make comparisons among diverse populations at risk or among competing technologies difficult.

We then identify four dimensions on which incurred and acceptable risk may differ:

(i) Historical aspects, or differences in risk due to technologies remaining somewhat static in time as society, societal attitudes, and competing technologies develop. For example, we now know how to better construct hydroelectric dams to be safer, but this does not help the safety of previously constructed dams.

(ii) Technical aspects, or differences due to ambiguities in the very definition of risk and to problems in the measurement of the parts and the whole of risk in any of its definitions. For example, it is an open question just how to calculate the probability of a core melt-down in a nuclear reactor.

(iii) Economic, or cost-benefit aspects, or tradeoffs that are made among competing hazards instead of from benefit to hazard. For example, certain automobile catalytic converters reduce the risk of illness due to pollution, but increase the chance of fire and related injuries.

(iv) Social aspects, or those political and subjective evaluations that institutions and individuals make regarding risk.

Our examination proves frustrating, however, in that we conclude that there is no methodology presently available that enables us to measure and integrate these four aspects into a single coherent risk component.

To arrive at our second finding - that different regulatory bodies seek to attain different risk-reduction goals - we apply the historical, technical, economic, and social aspects of risk in formulating objective risk-reduction goals. Using alternative energy technologies as an example, we construct ten different risk-reduction goals and show how they have been employed, sometimes explicitly and sometimes implicitly, by regulatory bodies. We also discuss how a decision to implement these goals could directly affect choices among alternative energy technologies. We then examine eleven alternative energy technologies, and show how it is possible (crudely, in our example) to measure directly the acceptability of each technology from the point of view of each of the risk-reduction goals. We then define a *risk-regulation strategy* as a self-aware commitment by an agency to a set of risk-reduction goals, taking into account the relative importance of the goals. We provide a simple means of how to express such a commitment, in the form of a traditional proportional weighting method by which a risk-regulation strategy is conceived of as a weighted (by relative importance) sum of its component risk-reduction goals. We provide examples of eight plausible risk-regulation strategies, some of which resemble current practice and some of which might be desirable strategies to pursue. Finally, we show how each of the proposed alternative energy technologies can be assessed as to its risk acceptability for any risk-regulation strategy. This assessment takes the form of a utility function, which takes the acceptability of the technology according to the goals of the risk-regulation strategy in proportion to their

importance as given by the importance weights.

Although the proper implementation of our proposed construction of risk-regulation strategies would demand complex measurement of both importance weights and acceptability measures for the risk-reduction goals, it has been our experience that the impact of the strategies is often largely realized by first-approximations to this complex measurement.

Our third finding - that the acceptability of selected energy technologies can vary significantly as a function of the nature of the risk-reduction goal - is integrated into our policy recommendations, discussed below.

Application to Policymaking: The Problem

In the context of risk-regulation policy, we desire some combination of alternative technologies which satisfies projected demands while minimizing adverse health, safety and environmental effects. The appropriate regulatory decisions must be made in light of many special interest groups with competing and conflicting priorities, all of whose inputs must be considered in the regulatory process.

In this context, an agency must evaluate these competing inputs against its own regulatory mandates and goals, in order to reach a regulatory decision. Specifically, a regulatory agency accepts experimental studies, technical analyses, statistics, etc. from their own labs or from independent contractors, from industrial firms attempting to promote a certain product or service, technical and social inputs from special interest groups either in favor of, or opposed to, such products or services, and from the public at large. An agency must judge not only the validity of these, but also which of these conflicting inputs will have the greatest weight in the final decision. Thus, within the context of its regulatory mandate from Congress and the President (i.e. within the freedoms and limitations of its "charter"), an agency has a certain latitude as to:

- o what information it will consider
- o how it will interpret such information
- o from whom it will accept inputs
- o how it will judge or weight, the inputs from specific contributors
- o how it will use the information in making a regulatory decision

The above represents what steps are required to make a regulatory decision. We contend that this is best done by utilizing an explicit, consistent set of goals chosen, and used, in an aware manner.

Application to Policymaking: A Goal-Oriented Approach

In elaborating on our policy recommendation - that the risk manager needs to be more self-aware in specifying what its risk-reduction goals are and how they relate to those of other agencies and the energy alternatives under study - we propose the following as an outline of how the methods discussed in the Report can be useful to policymakers.

The first step in this process is the determination of the appropriate goals *and their explicit recognition* (i.e., in writing). How can this be done?

Obviously, some of the agency or risk manager's goals are mandated by Congress. Within the limits of these, however, an agency can discern additional goals by:

- o considering the past regulatory decisions (what key factors led to a decision - *why* were these considered the key factors?)
- o recognizing explicitly the current staff practices, via staff discussions, and specifically tabulating these, including a weighting of their importance in agency decisions.

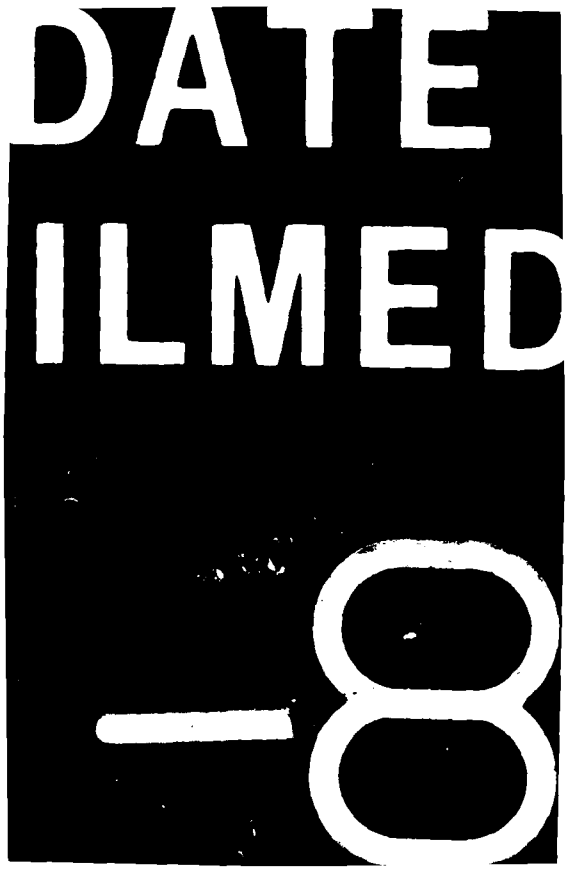
The result of this will be a set of goals, some mandated, and others varying from situation to situation.

As a second step, the risk manager can now analyze this set of goals. That is, by considering different combinations of the goals enumerated in step 1, and by weighting the inputs used in previous decisions, or the key risks and benefits of various energy technologies, it is possible

to see: (1) how different sets of goals would have affected previous decisions, and (2) how these sets of goals may affect the desirability of energy technologies under consideration by the agency.

As a third step, the risk manager should compare these sets of goals, and their effects, to the goals, and effects of goals, of others which regulate the same technologies. Clearly, DOE goals (and priorities) will differ from those of the Nuclear Regulatory Commission or the Environmental Protection Agency, for example; each agency has unique (and not always compatible) mandates. What is optimal for the general population is not identical with the optimal point for workers, for the national well-being, etc. Thus, some sort of balance must be struck - a balance which must vary with time, but one which should at least be based on an explicit recognition that agencies' goals differ and must not result in incompatible regulations on subject industries.

The fourth and final step, then, must be the adoption of a set of goals which represents the risk manager's explicit recognition of its role as a regulator, its long-term direction and priorities, and its interfacing with industry, the general population, and regulatory agencies.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